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ABSTRACT

This syllabus (which is not a teaching syllabus) is intended to be an essential minimum core syllabus in biology for children of all abilities. It consists of: (1) a foreword, which outlines how the syllabus was generated; (2) an introduction, which provides information about the use of the syllabus in biology teaching (for example, the local environment should be used as a basis for the study of biology whenever possible); and (3) the syllabus. The syllabus provides the minimum core content (theory and corresponding suggested student activities) separately for below average students and for average and above average students. Major content themes considered include: the diversity of organisms; relationships between organisms and the environment; organization and maintenance of the individual; and development of organisms and the continuity of life. (JN)

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A reduced-content 16+ syllabus in biology

A Working Paper prepared for the
Biological Education Joint Committee of the Royal Society and the Institute of Biology

January 1985

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JOINT ROYAL SOCIETY/INSTITUTE OF BIOLOGY COMMITTEE FOR BIOLOGICAL EDUCATION

REPORT OF THE WORKING PARTY ON REDUCTION OF 16+ SYLLABUSES IN BIOLOGY

1 FOREWORD

This report was inspired by:

1.1 The 1982 Royal Society Report 'Science Education 11-18 in England and Wales' recommending that all children in their fourth and fifth secondary years should be expected to spend about 20% of their curriculum time on science;

1.2 the realisation that for many children about one-third of this time will be spent on biology and allied subjects;

1.3 the GCE and CSE Boards' Joint Council for 16+ National Criteria document 'Recommended 16+ National Criteria for Biology' January 1983;

1.4 the Joint Royal Society/Institute of Physics Committee for Physics Education report 'A reduced-content 16+ syllabuses in physics'.

2 INTRODUCTION

2.1 This is intended to be an essential minimum core syllabus in biology for children of all abilities, envisaged as a part of co-ordinated science curriculum;

2.2 it is applicable to all courses regardless of the methods of assessment used;

2.3 it is based on the minimum core content set out in para. 4.6 of the 16+ GCE and CSE Boards' Joint Council for 16+ Criteria in Biology;

2.4 it is not intended to be a complete syllabus, but rather to match that document's recommended 70% of the biology to be taught during the last two years of compulsory secondary education, the other 30% being a development of this core in breadth and depth.

2.5 It is not a teaching syllabus: it is expected that any syllabus subsequently written for assessment purposes would cross-reference the material as was thought appropriate, and schools adopting such syllabus would determine the teaching order.

2.6 It is stressed that the subject should be taught from a practical basis, hence the inclusion of practical work.

2.7 The local environment should be used as a basis for the study of biology wherever possible.

2.8 In the light of the tendency to take all available syllabus contents into consideration and then add to them, an attempt has been made to reverse this process - particularly for the less able pupils. It must be emphasised that this is a minimum core to which further material should not be added simply because it appears in current syllabuses. It is hoped that a reduction in core content will allow the matching of conceptual difficulty to the pupils' capabilities, free the less able from a 'watered down' O-level course which is intellectually beyond them and irrelevant to their needs, and allow all pupils the time to adopt a practical approach wherever possible, acquire expertise in the processes of biology rather than merely a large body of facts, and apply these processes and facts to the world outside the school laboratory.

2.9 Unless otherwise stated, the material listed for children of lower ability should also be assumed in the syllabus for the more able pupils.

2.10 'Below average pupils' refers to those who would not in the current system achieve a grade 4 CSE. The other group refers to those who would on the same system achieve an O-level grade A-C or a CSE grade 1-4.

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3 MINIMUM CORE CONTENT

	Below average pupils		Average and above average pupils	
	Theory	Suggested practicals	Theory	Suggested practicals
3.1	Theme One : Diversity of Organisms			
	An outline of the theme only to illustrate the range of organisms from micro-organisms to flowering plants and to mammals using limited examples, and emphasising those occurring locally. Demonstration of the use of keys.	Observation of locally occurring organisms.	The theme illustrated by a suitably broad range of organisms.	
			The use of simple keys based on observable features.	The use of keys to identify local organisms.
3.2	Theme Two : Relationships between Organisms and the Environment			
	The sun as a source of energy for green plants. Green plants as a basis for food chains and oxygen supply.	Deduction of food chains through local observations.	Energy flow within ecosystems. Food webs and pyramids of numbers; biomass (for the more able only).	
	Cycles of matter as illustrated by the water and carbon cycles. Simple explanation of decay as caused by the feeding requirements of living organisms.	Observation and recording of decay; e.g. of a leaf.	Nitrogen cycle, including types of bacteria but not specific names.	
			Saprophytes as agents of decay.	Local survey to discover the range and type of saprophytes available.

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3.2 Theme Two (continued)

Below average pupils		Average and above average pupils	
Theory	Suggested practicals	Theory	Suggested practicals
Human interactions with the environment; e.g. food supply. Local initiatives and problems relating to conservation, recycling and pollution. Need to maintain balanced ecosystems to ensure cycles continue adequately; the importance of pollution in disrupting these cycles. The effects of pollution, including that by individuals; e.g. litter, on the quality of life.		Impact of social and industrial pollution on biological processes: role of biology in determining a scientific basis for pollutant control; e.g. acid rain, oil. The concern of biologists to maintain species, habitats and resources.	
Factors affecting population size as shown by competition. Effects of population on the environment. World population problems. Effect of changing balance in Western populations; e.g. longevity.	Observing and recording competition as seen in the growth of different moulds on bread.	A range of limiting factors affecting population size. The sigmoid growth curve. Predator/prey relationships.	

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3.2 Theme Two (continued)

Below average pupils		Average and above average pupils	
Theory	Suggested practicals	Theory	Suggested practicals
Transmission of disease emphasising indigenous examples, domestic animals and carriers. The prevention of these diseases. Parasites, especially microbes, as pathogens.	Elementary epidemiology.	The effect of pathogenic parasites on the body and the body's response to them.	
Individual and collective responsibilities for disease and its control; e.g. sexually-transmitted disease, public health, standards of hygiene in restaurants and food industries.	Culture of nonpathogenic micro-organisms to illustrate their transmission.		

3.3 Theme Three : Organisation and Maintenance of the Individual

Basic structure of plant and animal cells. Demonstration of modification by observing plant and animal tissues and organs.	Looking at, for example, cheek cells and onion cells.	Specialisation leading to modification at cell, organ and organism level.	Examination of a range of cells and tissues either by microscope slides or photographs.

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3.3 Theme Three (continued)

Below average pupils		Average and above average pupils	
Theory	Suggested practicals	Theory	Suggested practicals
Enzyme action. Enzymes as catalysts. Industrial uses of enzymes.	Examples of enzyme action e.g. amylase on starch, pepsin on egg white.	Catalysis. Intra- and extra-cellular activity of enzymes. Factors affecting the rate of enzyme-controlled reactions.	Effect of temperature, pH, and possibly enzyme concentration.
Diffusion - a simple explanation as illustrated by basic experiments.	Potassium permanganate in water.	Diffusion as the movement of particles affected by a concentration gradient.	
	I/starch in dialysis tubing.	Osmosis as a form of diffusion.	Classic osmosis experiments.
Life processes:			
A Photosynthesis as a method of trapping and storing energy.	Production of starch in the light; need for presence of chlorophyll; need for carbon dioxide.	Need for light, carbon dioxide, chlorophyll and the production of oxygen. Movement of carbon dioxide, oxygen and carbohydrate.	Effect of removal of carbon dioxide. Experiment to show production of oxygen; e.g. Priestley's experiment. Microscopic observation of leaf structure.

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3.3 Theme Three (continued)

Below average pupils		Average and above average pupils	
Theory	Suggested practicals	Theory	Suggested practicals
Life processes: (continued)			
B Basic nutritional requirements for healthy growth in: (i) plants - water, carbon dioxide, nitrogen, phosphorous, potassium; (ii) man - a balanced diet including energy needs. Awareness of current issues; e.g. famine, excess factors affecting food choice.		The importance of trace elements. The manufacture of amino acids using nitrates. Diet and enzyme activity.	Food tests as tools for laboratory organisation and manipulative skills, and the value of positive and negative results.
Digestion as a process leading to solubility.	Digestion of an insoluble substance leading to a soluble one.	Digestion related to enzyme activity.	Increased range of enzymes and substances. Use of semi-permeable membranes to show selective passage as in gut.
Gut regions in basic outline.		Gut structure related to function.	
C Transport and circulation of substances in: (i) plants - the need for water in photosynthesis and replacement of transpiration loss.	Movement of dye up stems. Rate of flow in stems with and without leaves.	Consequence in terms of water loss of large surface area for gas exchange. Root hair structure; xylem; factors affecting transpiration and uptake.	Use of potometer. Cobalt chloride paper to show water loss from leaves.
Transport of food from leaves.		Translocation in phloem to storage areas, growing points, etc.	Hales experiment to show effects on phloem of 'ringing'; e.g. in willow or elder stems.
Mineral salt uptake in solution (no details).		Active uptake of minerals.	

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3.3 Theme Three (continued)

Below average pupils		Average and above average pupils	
Theory	Suggested practicals	Theory	Suggested practicals
Life processes: (continued)			
C (continued)			
(ii) man - need for blood system; heart as a pump; associated 'first aid' and health issues e.g. smoking, stress, excess food intake, heart/lung machines.	Dissection (at least by demonstration) of heart.	Structure of heart, blood vessels and blood related to function (not heart cycle or chloride shift).	
D Respiration - energy release involving food and oxygen.	Burning food to show some idea of different energy values.	Aerobic energy release, anaerobic release in human muscle.	
Respiratory tract.	Experiments to investigate vital capacity and tidal volume of lungs.		Analysis of inspired and expired air for oxygen and carbon dioxide (simple experiments only).
E Excretion - the kidney as a remover of waste, toxins and water. kidney machine; transplants.	Dissection of a kidney.	Removal of metabolic waste through human skin, lungs and kidney (not fine detail of nephrons). Outline of osmoregulation.	

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3.3 Theme Three (continued)

Below average pupils		Average and above average pupils	
Theory	Suggested practicals	Theory	Suggested practicals
Life processes:			
F Sensitivity in: (i) plants - phototropism in stems, geotropism in stems and roots (not mechanism).	Cress in the light, dark and unidirectional light. Experiment to show geotropism.	Action of auxin to show chemical co-ordination regulating differential growth in photo- and geotropism based on experiments which are replicable in the school laboratory. Role of auxins in modern agricultural practice.	Indolylacetic acid on seedlings to show the effect on stems and roots. Clinostat.
(ii) animals - sight, hearing, taste, smell, balance and skin senses based on the pupil's experience without detailed knowledge of structure.	Simple taste experiments. Effect on taste when nose pinched. Advantage of two eyes. Field of vision. Range of hearing. Directional nature of hearing.	Structure of the eye and ear related to function (not detailed structure of the organ of Corti).	Distance between eyes when observing near and far objects.
G Locomotion. Antagonistic muscle action at a joint. Associated 'first aid' and health problems. Artificial limbs. Hip replacement. Physical fitness related to muscles and bones. Effect of stress on joints and muscles.	Observation of fresh specimens to see joints e.g. dissection of a pig's trotter. Observation of muscle action during exercise.	Basic human skeleton (naming only major bones). Bone as living material. Types of joints.	Burning bone. Action of acid on bone.

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3.3 Theme Three (continued)

	Below average pupils		Average and above average pupils	
	Theory	Suggested practicals	Theory	Suggested practicals
	Life processes:			
H	Co-ordination, nervous and hormonal control. Central nervous system and its role in co-ordination (no structural details). The idea of a peripheral nervous system linking muscles, glands and organs to the central nervous system.			
	Reflex action through the pupil's own experience.	Pupillary size in light and dark. Knee-jerk reflex.	Such structural details as are necessary to understand reflex arc (not limited to the knee-jerk). An example of innate and of learned behaviour.	Choice chambers. Invertebrate response to light.
	Adrenalin, sex hormones and an outline of the role of insulin in diabetes.		Thyroid. Detailed role of insulin in carbohydrate metabolism; outline of pituitary control.	
	Homeostasis as illustrated by temperature control.	Skin and body temperature before and after exercise.		

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3.4 Theme Four : Development of Organisms and the Continuity of Life

Below average pupils		Average and above average pupils	
Theory	Suggested practicals	Theory	Suggested practicals
Chromosomes solely as carriers of hereditary factors.		Chromosomes and DNA. Importance of constant number in mitosis. Meiosis as reduction division (no stages of cell division).	Chromosomes in plant root tips.
Growth as cell division and enlargement.	Rate of growth e.g. bean.	Measurement of growth by experiment.	Dry mass.
Reproduction: (i) Asexual by cuttings, etc.	Growing cuttings.	Lack of genetic variation.	
(ii) Sexual in (a) plants - one flower as an organ of sexual reproduction.	Simple flower dissection. Looking at pollen.		Growing pollen tubes.
(b) humans - gamate production, prenatal care, birth care of the young child. An emphasis on removal of old wives' tales.			

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3.4 Theme Four (continued)

Below average pupils		Average and above average pupils	
Theory	Suggested practicals	Theory	Suggested practicals
Inheritance of variation as shown by domestic animals and crops.		Variation as caused by mutation (also v.s.). Environmental and genetic variation. Variation leading to evolution, including modern examples e.g. warfarin resistance in rats.	Bead genetics.
		Genetic engineering.	
Natural and artificial selection as shown by domestic animals and crops, leading to the concept of evolution.			

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